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ABSTRACT

This study evaluated the design and effectiveness of an interactive videodisc package which was developed at the Open University for a second level course in metallurgy and materials technology. Based on an existing 25-minute television program from the course, the disk put the problem in the form of a court case assessing the responsibility for blindness in teddy bears; whether it was the fault of the manufacturers of the teddy bears' eyes, or the people who made the washers that held the eyes in place. The methods used to evaluate were observation, interviews, and questionnaires; a total of 40 students were observed while using the instruction, 9 students were interviewed after finishing the package, and 20 completed the post-instruction questionnaire. Observation and questionnaire data showed that, on the average, students used the package twice, with a range of from one to six times. Students liked the format, i.e., the continual interrogation and the variation in presentation. Design features that made the videodisc educationally useful were identified as: (1) it made students think; (2) it provided feedback that guided students toward the right answer; (3) it helped students relate theory to practice; (4) it gave students some control over surrogate experiments; (5) it promoted academic discussions; and (6) it focused attention on the subject matter for long periods. The two main aspects of the design package that created problems for students were the open-ended question format and the linear structure of the interaction and information. Costs of developing the package and an eight-point summary conclude this report. (JB)

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VIDEODISC EVALUATION REPORT

'The Teddy Bears Disc'

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November 1984

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VIDEODISC EVALUATION REPORT

'The Teddy Bears' Disc

D.M. Laurillard

DESCRIPTION OF THE INTERACTIVE VIDEO DISC

The disc was developed for a second level course in technology, on the structure of materials. The course covers a wide variety of concepts in metallurgy and materials technology, and the aim of the disc was to provide a synthesis of all these by bringing them to bear on a real life problem. The video was used to present the problem, its context, and the visual aspects of the concepts involved; the computer interaction was used to allow the student to perform surrogate experiments, and to test their knowledge and understanding of the content.

The structure of the disc was based on an existing television programme from the course, which put the problem in the form of a court case assessing the responsibility for blindness in teddy bears: was it the fault of the manufacturers of the teddy bears' eyes, or did the fault lie with the people who made the washers that held the eyes in place? The court had to hear the arguments from both sides, and decide the issue on the basis of evidence about the properties of the materials involved.

The structure of this programme gives a framework to the material presented on the disc, and provides a rationale for the integrated computer-based exercises. The barristers set up the problem at the beginning of the trial; the video stops and the computer gives the student the opportunity to predict possible causes of eye-loss by the teddy bears, guiding them towards the concept of 'environmental stress'; returning to the trial, this point is reinforced as the prosecution makes the case that the cause could have been environmental stress, but the defence counters by claiming that the changes made in the washers were irrelevant to this; back to the computer-controlled simulation of experiments to check the validity of this claim, using some video still-frames; and so on... Thus the student experiences a continual alternation between video sequences lasting four to five minutes, and computer-controlled exercises lasting 10 to 15 minutes.

The software used to control the disc incorporates facilities taken from the STAF2 authoring language, which allows open-ended questions to be put to the student, who then has to construct their own answer by typing it in from the keyboard, or by typing in a numerical answer to a calculation. A sophisticated answer-matching routine ensures that, for the majority of cases, the computer can handle the student's input in a sensible way. The computer-generated text is displayed as Teletext overlay on the disc-generated video.

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The hardware used for this implementation was:

an Apple II with 2 disc drives and a language card

A Philips Laservision player, VP705

A California Computer Systems 7710A serial interface card

A Pye television with Teletext facility

The videodisc and the interactive software were produced by a collaboration between Paul Blenkhorn, (then ACS), Stephen Brown (then IET), Phil Butcher (ACS), Keith Williams (Technology), and Martin Wright (BBC/OUP).

EVALUATION

The educational evaluation of the interactive videodisc package had two main aims:

to find out what kinds of improvements could be made to the software

to describe students' experiences of this kind of learning method.

There was no attempt to carry out a comparative study between interactive video and other methods, as too many variables are different, and it would not be a meaningful comparison.

The evaluation was conducted at the Open University summer school for T252: Structure of Materials, in July 1984. Two work-stations were available for students to use in their free time, which, given the heavy scheduling of the T252 summer school, amounted to evenings only. Students used the package in ones or twos, on a voluntary basis, returning for further sessions if they wished. Instructions for the operation of the disc, and advice on what was available, were given both at the beginning of the disc, and in text form on the wall next to the work-station. The sessions were usually unsupervised, and students were not required to submit any record of their work. Information about the availability of the videodisc package was given to students at the start of the summer school, and it was emphasised that this was optional work.

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The evaluation methods used were:

Observation - recording students' actions and conversations, and the timing of these, recorded on pro-forma sheets,

Interviews - informal discussions with students after they had finished using the package, recorded in note form,

Questionnaires - designed on the basis of initial student comments, filled in by students after their work on the disc (see Appendix 1).

Altogether 40 students were observed, in groups of one and two, 9 students were interviewed, and 20 completed the questionnaire. The results below are based on this information.

STUDENT EXPERIENCE

One of the best ways of assessing students' perception of the value of a learning method is to establish how much they used it. From observation and questionnaire data, students used the package, on average, twice, with a range of one to six times. Given that students are extremely careful about their use of their very limited time for study, this repeated usage is a tribute to the perceived quality of the disc. What they liked was the form of the method, the continual interrogation and the variation in presentation. The questionnaire asked students to mark those descriptions of the package they particularly agreed with, and three-quarters said:

It made you think about things you weren't sure you knew,

and

It was a good way to learn, combining questions with short breaks for video.

We can conclude, therefore, that whatever its actual value, the perceived value of the method was high.

The observation study showed that one advantage of this type of method is that it holds the students' attention for a considerable length of time. Most of the open-ended comments on the questionnaire made the point that there was too much material on the disc, and that the package took too long to complete. The observation study recorded an average time to complete the package of two and a quarter hours, with a range of one to three and a half hours. This is a long time for students to spend on optional work, and moreover it was concentrated work - the interrogative form of the package promoted a lot of discussion, and the gradual progression towards a solution kept students working steadily, often beyond the time they meant to stop (namely closing time!).

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The response from students is encouraging. It suggests that at least the method is a feasible one in the sense that students find it enjoyable and feel they are learning something.

DESIGN FEATURES AND THEIR RELATION TO LEARNING

The second main aim of the evaluation was to describe how the method worked, and to provide lessons for the design of future interactive videodiscs. We need to know the answers to general questions such as:

What kinds of interaction are possible?

How should a disc be structured?

What do students need to help them learn in this way?

In this section we consider the design features of disc and software that were successful in encouraging students to think about their subject, and to practise the reasoning processes and procedures that they need to become competent in their field.

Forms of Interaction

Several different forms of interaction were used on the disc, where interaction is defined to refer to the interval between two consecutive key presses by the student, i.e. the time taken to read the question, decide on the answer, and input the answer, or to watch a section of video, read the instruction and press return to continue.

The following types of interaction were used. They are listed roughly in order of frequency of occurrence, together with a description of their value to students:

Information testing (e.g. "Which class of polymers fail in a brittle way?) - it was this form of interaction that forced students to realise that they did not always know what they thought they knew.

Information giving (e.g. "Glasses have random molecular arrangement and exhibit to step change") - this type of feedback on their answers gave students remedial tuition where necessary.

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Tested observation (e.g. "What do you notice about yield stress after plastic deformation?") - this type of question gave students most trouble, because many of them required the interpretation of pictures such as micrographs (pictures of metals photographed under a microscope). Students often needed help in recognising which parts of the picture were salient, and in identifying what they meant. In some cases this help was offered in the form of a hint, using teletext overlay, labelling the relevant part of the picture. This was a very useful, and often necessary device.

Untested observation (e.g. "Look at the end-on views of fracture surfaces") - this form of interaction made extensive use of the still-frame and slow-motion operations on the videodisc. Students were left to view these at their own pace, either by cycling round a set of stills by pressing return, or by requesting a repeat of a motion sequence. In most cases, students were unsure what they were meant to be looking for, and so treated these interactions in a rather cursory way. There was no encouragement for them to do anything particular with their observations, so they had little apparent educational value.

Hypothesis-framing (e.g. "What is the cause of the eye-loss?) - questions of this type gave students the opportunity to marshall their knowledge and understanding of the subject and bring it to bear on a real-world problem. These questions provided the overall framework of the package and helped to bridge the gap between theory and practice. In the questionnaire, half the students agreed that the package helped them to "see the need for the theory involved".

Procedural information (e.g. "Ultimate tensile strength can be read off the vertical axis") - feedback to students who gave incorrect answers took several forms, of which we have already seen 'information giving'. Procedural information was used where it was necessary not just to give the student the answer, but to help them to see how to get there.

Hints (e.g. "Think about the specimens you have already seen") - a third form of feedback guided them towards the answer without actually giving it.

Instructions (e.g. "Be more precise, try again") - it was important sometimes to recognise that unexpected answers may not be wrong, and that students should simply be encouraged to use the scientifically correct term.

Simulations (e.g. "Halt the test at the yield point") - this type of interaction made best use of both video and computer together, as the computer would check, for example, how many frames into a video sequence the student went before stopping. It is possible to allow the student to carry out 'surrogate' experiments in this way, where, to some extent, they operate and control what happens and when. The simulations were given added realism in comparison with the typical CAL simulation by the use of video. In the questionnaire, half the students agreed that "the pictures made it much better that the CAL tutorials".

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It is difficult to give an exact assessment of the relative learning gains provided by these various forms of interaction. It would require detailed testing, which would interfere with the flow of the educational interaction, and in any case would not necessarily isolate the exact learning gain due to one type of question, rather than the accumulation of learning from a series of questions. Evaluation studies that attempt to prove that one form of learning is more efficient, or better than another, are doomed to failure for this sort of reason. The descriptions above serve to show the kinds of learning experience these different forms of interaction provide, and the relationships deduced have been further supported by evidence from the interviews and questionnaires.

In addition, the observation schedule allows us to compare the time taken for different forms of interaction, and to assess what kinds of student response they promoted. Overall, the average time spent on one interaction (the time between consecutive key presses) was approximately one minute. In general, less time was spent on hypothesis-framing and information-receiving, and more time was spent on observation and testing. The latter frequently promoted discussion and argument among the students, which in some cases had the beneficial effect of making students explain their answers to each other, before having them checked by the computer (but see below).

The time spent on procedural information, instructions and hints was variable, but depended more on the amount of reading to be done than on thinking time. Similarly, the time spent on simulations depended more on the running time of the video.

To summarise, the various design aspects of this videodisc make it educationally useful because it can

(a) make students think

(b) provide feedback that guides students towards the right answer

(c) help students relate theory to practice

(d) give students some control over surrogate experiments

(e) promote academic discussion

(f) focus attention on the subject matter for long periods.

DESIGN PROBLEMS

There were two main aspects of the design of the package that created problems for students: the format and the structure of the interaction and information.

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Open-ended question format

The use of an open-ended question format together with a sophisticated answer-matching routine meant that it was possible to design a quite challenging dialogue which was a genuine test of students' understanding of the subject. As reported above, this aspect of the design was appreciated by students, but it was not without its problems. The information-testing form of question promoted three types of discussion among students, in addition to deciding what the content of the answer should be:

how to phrase it,

what keywords the computer might look for,

what level of answer is appropriate (e.g. at microscopic or macroscopic level).

These are all similar to the problems of communication between teacher and student in any tutorial situation. It is common for the classroom teacher to expect a particular form of words in an answer, and to accept nothing else. It is not pedagogically sound to inhibit students' thinking in this way, but the computer is doing nothing worse than behaving like a normal teacher. More serious are the problems that occur when the computer misinterprets a student's answer.

When a student inputs a correct answer that is not recognised as such by the computer, three different types of student reaction result:

(a) they experience mild indignation, which is not serious in itself, but can accumulate to undermine the student's confidence in the value and authority of the program,

(b) students learn to 'play the game', and begin to focus on beating the computer, rather than on the subject matter itself,

(c) students accept their own ignorance and search for an alternative (i.e. wrong) answer.

These are all pedagogically unsound, especially the last, and are inevitable consequences of an imperfect answer-matching format. The pilot run collected all student input, and stored it on diskette for later analysis, so that more alternative correct answers could be programmed in. The disadvantage for the pilot students decreases for later students, but there is always a risk that further alternative correct answers will be thought up.

The computer never gave a wrong answer as right, but sometimes students were told they were right when they had only guessed. This meant that they were branched away from the remedial tutorial they needed.

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This point raises the tricky question of what should be done about student versus program control. The advantage of student control is that the student knows better than the computer does whether or not they need remedial help. In the questionnaire, half the students agreed they should be "branched to remedial tutorials if they keep getting things wrong" - which shows that they are not reluctant to be helped when they know they need it. The advantage of program control is that the student can maintain continuous concentration on the subject matter, uninterrupted by tedious questions about what they want to do next. Perhaps the solution is to combine the virtues of both by having an 'override' option that the student can use if they wish to avoid a section. This was, in fact, provided in the form of a 'skip' option, but students were very uncertain how to use this - they did not know how far they were skipping, and had no way of telling how far they needed to skip. The precise format of helpful user interface features such as this is an issue worth considerable attention if interactive video is to become a user-friendly medium for learning.

The Structure of Information

Because the disc was designed around an existing television programme, the framework this provided was inevitably linear. There was little opportunity for students to take their own route through the material, and there was no information to help them to do this.

It was also clear that using a videodisc creates orientation problems for students. It is difficult to know at any one point where they are in relation to the material as a whole, how much they have done, how much there is yet to do. Since the original design, several specific changes have been implemented to assist students in finding their way around the information on the disc:

It is possible to stop the video at any point and choose the next action from a menu of options.

The student can find out at any point where they are in relation to the material as a whole.

Students are given an estimate of how long each section might take them.

The contents list has been expanded from one to fifteen lists, in order to provide more detailed information about what is available.

Students can call up the contents lists at any time to change their route through the material.

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The amount of control given to a student in their use of a videodisc is a matter of choice of teaching strategy. The strategy used in this disc was mainly program control, which made it highly didactic. This is not a necessary feature of interactive videodiscs - they could embody a more student-controlled, exploratory strategy. Then the accessibilitiy of information on the disc becomes crucial. But even in this relatively controlling programme, it has still been found to be important to give students sufficient information for them to have a degree of control over what they do and when.

COSTS OF DEVELOPMENT

These are estimated costs, based on the fact that the disc used 20 minutes of existing video material, 15 minutes of new motion sequences, and 370 new still frames. It is difficult to provide meaningful estimates of programming time for future projects because development was switched from the Apple to the DEC20 part way through, and software was written for two videodisc drives, one for the Pioneer, and one for the Philips when we switched to that. In addition, some of the originally programmed teaching material has been completely redeveloped in the course of the project. This is probably to be expected, however. The following estimates do not include software development time that can be expected to be one-off, such as programing for the disc-drive.

Principal staff involvements

Academics	50 days
Video producer	80 days
Programmer	100 days
Graphics designer	70 days
Graphics assistant	70 days

Mastering costs	£2000
Pressing costs (200 copies)	£2000

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SUMMARY

The main points to have come out of this study which should be relevant for future developments are as follows:

(a) Students found the continual interrogation and the varied presentation a good way to learn.

(b) These features also kept students working in a concentrated way for long periods.

(c) The most educationally successful forms of interaction were information testing, hypothesis framing, and simulations.

(d) Observation by students and testing of students took the most student time, the latter because it often promoted discussion.

(e) Student-constructed input, with an answer-matching algorithm, sometimes makes it difficult for students to know what kind of answer is expected, and discussion is about this, rather than the substantive issue.

(f) Students need some control over the presentation of information.

(g) A 'skip' option needs to be backed up with information on how to use it and what its effect is.

(h) A 'contents' list should be accessible at any time, and should be detailed enough for a student to be able to make sense of it.

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Your answers to these questions will help us decide how the disc could be improved and how it should be used.

1. How many times have you used the disc? _____

2. How much time have you spent on it altogether? _____

3. The following statements are all quotes from students who have used the disc. Please tick just those statements you particularly agree with.

(a) It made you think about things you weren't sure you knew

(b) It was a good way to learn, combining questions with short breaks for video

(c) The pictures made it much better than the CAL tutorials

(d) It helped by bringing a lot of things together to relate to a real problem

(e) It helped me see the need for the theory involved

(f) I got very interested in the problem

(g) There was a tendency to lose track of what you were doing

(h) Too often it did not understand my answers

(i) I wanted to be able to do more actions myself, not just answer questions

(j) You should be branched automatically to more remedial work if you keep getting things wrong

(k) There is not enough labelling on the pictures

(l) I needed more information to be able to use it as I wanted (e.g. did not know when I had finished a section, could not escape at any point, no index, etc)

4. Any further comments?

NAME (optional)_____

THANK YOU FOR YOUR HELP

Diana Laurillard, IET,

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